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Clover Creek/Morey Creek Study:
McChord Air Force Base, WA

Completed by:

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CEE Graduate Program

May 2000

Abstract:
In response to the growing concern regarding its impact on the water quality of Clover Creek, McChord Air Force Base, Washington started a monitoring program. The purpose of this study is to analyze the data that has been collected over the past five years and make recommendations for improvements to the monitoring program. There is a special focus on nutrients levels like nitrate and phosphate since Lake Steilacoom, which eventually receives the water, has had algal bloom problems associated with eutrophication. The conclusions drawn from the data collected by the Air Force from March of 1995 through January of 2000 and additional stream observations are: (1)in general, nitrate concentrations increase slightly as the creek flows through the base, (2)phosphate concentrations do not increase as the creek flows from inlet to outlet, (3)dissolved oxygen data is insufficient, (4)temperature and pH readings are below Washington State Water Quality Standards for the most part, (5)and phenol, oil and grease, and metals tested for, have some value for monitoring efforts. Recommendations for improving the monitoring program include creating a comprehensive binder that includes specific goals; where, what and when to monitor; explanation of training for sampling personnel; using standards methods for sampling techniques; and setting up a better data base that is reviewed as the data is received. These changes will add credibility to the monitoring program and enhance its value to the Air Force Base.

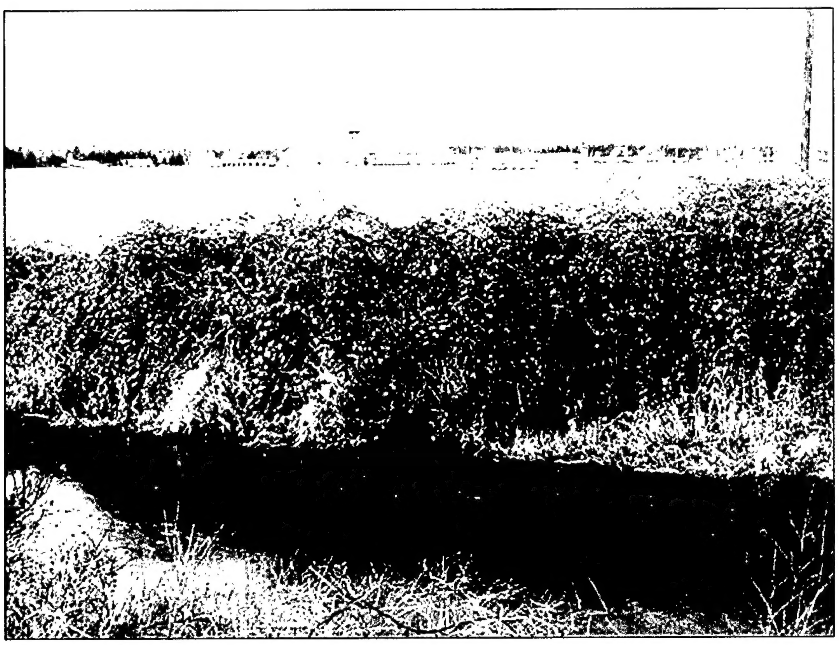

Figure 1: Clover Creek Inlet with airfield in background.

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Introduction:
Streams are not only functional aspects of the environment; they contribute to the beauty of the world around us. Especially in urban areas, unpolluted streams contribute to our quality of life. As stewards of the land it is important to monitor the health of the streams we affect. They are continually being bombarded with our storm run offs, point pollution and non-point pollution. Urban areas (and Air Force Bases) tend to have more land covered by impervious surfaces, like runways and parking lots (See Figure 1: Clover Creek Inlet). This causes run-offs to be more pronounced and concentrated. Erosion can potentially become a problem in the stream channel and banks increasing the concentration of pollutants going directly to the stream instead of being filtered by the soil or absorbed by the plants.

Some streams, like the ones in this study, act as the main receiving body for storm water run-off. Ensuring that the stream remains healthy is important to those that enjoy the stream, use the stream, live in and around the stream, and receive the stream. A receiving lake is susceptible to pollution (both nutrient and toxic) that come into the system from the feeding streams. Water is a precious and necessary resource that is well worth monitoring and protecting so that the biological community can continue to enjoy its beauty and life giving properties.

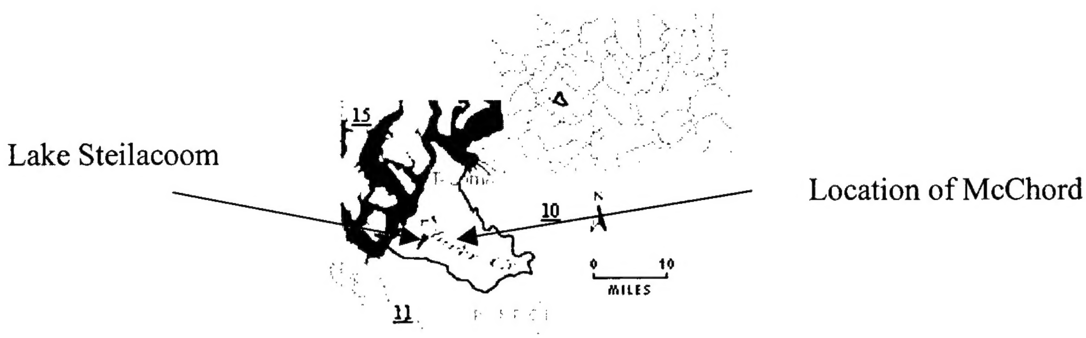

Figure 2: Map of WRIA 12: Chambers-Clover Watershed

Background on McChord's Creeks:
McChord Air Force Base is located in Tacoma, Washington within the Water Resource Inventory Area 12 (WRIA). Figure 2 shows the location of WRIA 12 in the state of Washington. Morey Creek and Clover Creek enter McChord AFB on the eastern boundary of the base and flow east to west for less than 2 miles across the base as they form one stream, Clover Creek. (Please refer to Attachment 1: Map of McChord AFB for more detail). This stream was relocated in the late 1930's from its natural channel to make room for the airfield. It also runs underground in two corrugated steel pipes for a small portion of the time while on base (~ ¼ mile). The creek contains native cutthroat trout. In addition, before Morey Creek merges with Clover Creek, a concrete dam forms a small pond.

Clover Creek originates from Spanaway Lake located to the southeast of the base. This lake is a shallow lake that often has problems with eutrophication. The springs that feed the lake are high in phosphates according to Stephen Chapel, City of Lakewood Associate Civil Engineer.

The combined stream is classified as Class A (Excellent) IAW Chapter 173-201A: *WAC Water Quality Standards for Surface Waters of the State of Washington*. Class A Streams require the following for Water Quality:

Dissolved Oxygen concentration	> 8.0 mg/L
Temperature	May not exceed 18°C due to human activities
pH	6.5 – 8.5
Turbidity	< 5 NTU + Background (when background <50 NTU)
Aesthetic Values	No unnatural suspended, floating, or submerged matter

Table 1: Water Quality Standards

The waters being evaluated in this study flow from a residential area before entering the base and exit into a commercial and residential area. Overall, WRIA 12 is classified as urban. Eventually the creek flows into Steilacoom Lake in the city of Lakewood. Monitoring the creek is important since Steilacoom Lake contains algal blooms. These are suspected to occur, according to Dr. Brett, a University of Washington faculty member, due to high concentrations of phosphate and low concentrations of nitrate (respectively). This allows cyanobacteria to out-compete other algae and bacteria and causes the problems seen in the lake.

McChord AFB is an easily identifiable and regulated contributor to the creek due to the extensive documented storm water system it manages and its high profile mission. Due to these aspects, McChord AFB is often the recipient of complaints and needs the ability to assess their impacts on the stream in a reliable, reproducible manner.

Regulatory Environment for Clover Creek:
Clover Creek and Morey Creek receive the storm water runoff from the base. Storm water discharges are regulated under the nation-wide EPA General Storm Water Permit and are specified in federal regulations (NPDES permit number: WA-002510-1 issued by the EPA on 11 Feb 1975). An important item of the permit is preparation of a storm water management plan. The plan for McChord AFB requires analysis of the storm water utility system, holding committee meetings and doing visual inspections of the outfalls received by Clover Creek. According to Mike Grenko, Chief of the Environmental Flight at McChord AFB, the strictest requirement in the program is visual monitoring of the stream on a quarterly basis. During a visual inspection, the observer looks to see if there is an oily sheen visible or any other change in the nature of the water. Testing for traces of dissolved chemicals is neither done nor possible during this visual only monitoring.

In addition to the visual inspections, every major outfall to Clover Creek runs through an oil/water separator. This process removes oily sheens from the top one to two inches of storm water. The stream receives no industrial discharges. Any water that may pose a risk is plumbed to the sanitary sewer system and treated at Fort Lewis, Washington.

Original Monitoring Goals:
In response to community inquiries about stream water quality, McChord AFB started voluntary monitoring of the creeks. The public's claim that McChord AFB was seriously polluting Clover Creek led to the decision to start collecting data where the stream enters the base and where it exits the base. This database was intended to support any position McChord AFB would take

with respect to water quality in Clover Creek for the portion that flows through McChord AFB. Especially important is the data collected on phosphate and nitrate concentrations due to the receiving lake having algal bloom problems.

Information on Nutrients and Eutrophication:
Since one of the focuses of the monitoring program is to determine the effect McChord AFB has on the nutrient levels in the creek, background information on nutrients and eutrophication is provided.

Eutrophication was originally a term used to describe the natural aging process of a lake as it is transformed from a lake to a marsh to a meadow (Chapra 1997). Normally this process takes thousands of years but it can be accelerated by excess nutrients from human activities such as fertilizing crops and detergent use. The process is sometimes called "cultural eutrophication"; which needs to be closely monitored and prevented so that the lake can continue to be healthy and take its' natural course.

Certain levels of nutrients, however, are needed for growth of plants and animals. Nitrogen and phosphorus are two essential and primary controllable nutrients. Nitrogen is one of the inorganic macronutrients necessary and provides chemical building blocks for life. It is present is in four primary forms: free nitrogen (N_2), ammonium (NH_4^+)/ammonia (NH_3), nitrite (NO_2^-)/**nitrate (NO_3^-)**, and organic nitrogen (Chapra 1997). Phytoplankton and fixed plants can utilize both ammonia and nitrate, aerobic bacteria can oxidize ammonia and nitrite to nitrate (nitrification), free nitrogen can be utilized by nitrogen fixing algae and bacteria, and organic nitrogen decomposes to ammonia. These interconnected cycles are important for understanding nitrogen as a nutrient. Nitrate as a pollutant occurs when the concentration of nitrate gets too high usually due to agricultural fertilizers.

Phosphate is the other macronutrient often focused on because it is usually in short supply relative to other nutrients. **Phosphate** is part of the soluble reactive phosphorus group also called orthophosphate and is readily available to plants (Chapra 1997). It can be derived from many sources. Particulate organic phosphorus that includes living plants, animals, bacteria, and organic detritus forms nonparticulate unavailable organic phosphorus that then becomes the phosphate available to plants. Human and animal wastes both contain substantial amounts of phosphate. In addition, fertilizers and detergents used by humans also contribute to natural water concentration increases.

Washington state surface water quality standards do not address specific levels for nitrate and phosphate concentrations since it varies depending on the water body. Water clarity, pH, dissolved oxygen (DO) and specie composition are analyzed instead. These parameters help indicate the health of a stream since concentrations of nitrate and phosphate do not give an accurate picture.

This study will analyze the data provided (Attachment 2) and also make recommendations for a quality-monitoring program so that when a public presentation of the data is given, the presented data will be credible, reliable, and understandable to the general public.

Data Analysis from Present Monitoring Program:
Grab samples have taken place from March of 1995 until January of 2000. The samples for metal analysis are preserved in nitric acid and sent to Brooks AFB, TX. The results are recorded and kept by the Bioenvironmental Engineering Services on base. The rest of the samples are sent to Water Management Laboratories in Tacoma, WA and use the EPA method 1664 N-Hexane Extractable Material (HEM) analysis. The silica gel treated HEM are analyzed by extraction and gravimetric analysis.

The data points available are difficult to compare and analyze due to gaps in the data and the lack of stream flow data. Even though there is a log for stream flow data kept with the other data, no observations have been made. Flows are important in order to perform a mass balance to better determine the affect McChord AFB has on the streams. The data, however, are presented below and analyzed.

Nitrate:
A rough analysis of the available data is presented here. The results can best be seen in a tabulated form. By assuming that the flows from the two inlets are somewhat equal, the average of the two concentrations can be compared to the Clover Creek Outflow from the base.

DATE	CCI	MCI	Average	CCO	Change	
3/24/1995	1.96	1.8	1.88	1.8	-0.08	Decrease
6/8/1995	1.22	1.34	1.28	1.6	0.32	Increase
7/26/1995	0.59	0.78	0.685	0.94	0.26	Increase
11/7/1995	0.82	0.56	0.69	0.44	-0.25	Decrease
1/29/1996	1.3	2.12	1.71	1.9	0.19	Increase
4/8/1996	1.48	1.38	1.43	1.38	-0.05	Decrease
7/17/1996	0.68	0.97	0.825	1.15	0.33	Increase
10/7/1996	0.56	0.8	0.68	1.32	0.64	Increase
1/29/1997	1.58	1.8	1.69	2.08	0.39	Increase
4/9/1997	1.26	1.32	1.29	1.35	0.06	Increase
7/2/1997	0.35	0.68	0.515	0.75	0.24	Increase
10/13/1997	0.38	0.56	0.47	0.56	0.09	Increase
1/14/1998	1.2	1.36	1.28	1.34	0.06	Increase
4/8/1998	1.28	1.3	1.29	1.26	-0.03	Decrease
10/14/1998	0.32	0.52	0.42	0.68	0.26	Increase
3/19/1999	1.7		1.7	1.8	0.10	Increase
4/21/1999	1.4	1.4	1.4	1.5	0.10	Increase
7/29/1999	0.8	1.2	1	1.2	0.20	Increase
10/15/1999		0.03	0.03	0.05	0.02	Increase
1/12/2000	1.3	1.5	1.4	1.4	0.00	No Change

Table 2: Nitrate Data

*CCI is the Clover Creek Inlet **MCI is the Morey Creek Inlet ***CCO is the Clover Creek Outlet
- all concentration are in mg/L

It appears from this analysis that McChord AFB does have a slight effect on the nitrate concentration as the creeks flow from inlets to outlet. Most of the time the concentration slightly increases, but these increases are relatively small when compared with the initial concentrations. The reason for this increase could come from a variety of natural sources, not related to military activities on the base. Similar to the complaints about Canadian geese adding to the algal problems at Green Lake in Seattle, WA, there are a significant number of waterfowl (see Figure 3) that make the creek a resting spot. There is ample of vegetation degrading that could be adding to the nitrogen concentration. More water quality data, like DO in relation to the background provided earlier, would need to be collected before attempting to determine where the minute addition of nitrate is coming from.

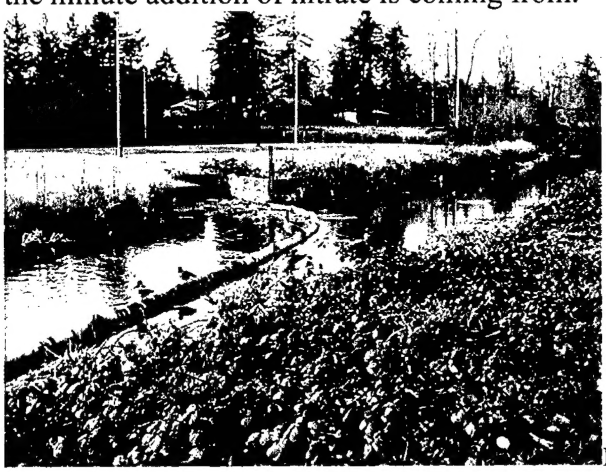

Figure 3: Clover Creek Outlet showing waterfowl and the permanent barrier used to prevent any accidental oil spills from McChord AFB going off base.

Below is a seasonal analysis that can be useful in general analysis of the stream. In the winter and spring the concentrations are generally higher than the summer and fall. This seasonal variation could be due to many things. One hypothesis is that the plant uptake of nitrate during the warmer summer and fall months is greater due to their productivity level and this decreases the nitrate concentration. The second hypothesis is that due to more oxygen being available in the water during the cooler seasons, oxidation to nitrate during the winter and spring increases the nitrate concentration. More than likely increased precipitation in the winter and spring increases the run off to the creek and picks up nutrients that had been dry and immobile during the drier seasons. (Migration of waterfowl may also play a role in the variation.)

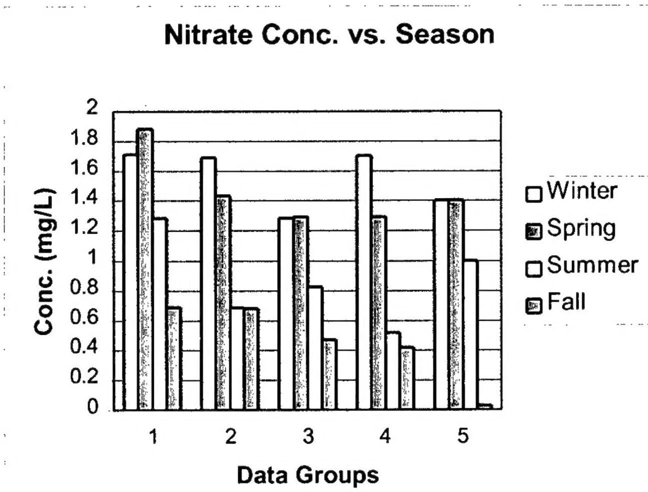

Figure 4: Seasonal Analysis of Nitrate Concentration

Phosphate:

Phosphate data points were consistently <0.1 mg/L. The measured concentrations are not quite as interesting as the nitrate values, but add to the knowledge about the quality of the water samples. A different test is needed that can detect concentrations to values of .01 accuracy. The table below summarizes the data.

DATE	CCI	MCI	Average	CCO	Change	
3/24/1995	< 0.1	< 0.1	< 0.1	< 0.1	0	No Change
6/8/1995	< 0.1	< 0.1	< 0.1	< 0.1	0	No Change
7/26/1995	< 0.1	< 0.1	<0.1	< 0.1	0	No Change
11/7/1995	< 0.1	< 0.1	<0.1	< 0.1	0	No Change
1/29/1996	0.013	< 0.11	0.0615	0.11	0.049	Increase
4/8/1996	< 0.1	< 0.1	<0.1	< 0.1	0	No Change
7/17/1996	< 0.1	< 0.1	<0.1	< 0.1	0	No Change
10/7/1996	< 0.1	< 0.1	<0.1	0.2	>.1	Increase
1/29/1997	< 0.1	< 0.1	<0.1	< 0.1	0	No Change
4/9/1997	<0.1	<0.1	<0.1	<0.1	0	No Change
7/2/1997	<0.1	<0.1	<0.1	<0.1	0	No Change
10/13/1997	< 0.1	< 0.1	<0.1	< 0.1	0	No Change
1/14/1998	< 0.1	< 0.1	<0.1	<0.1	0	No Change
4/8/1998	<0.1	<0.1	<0.1	<0.1	0	No Change
10/14/1998	0.27	0.03	0.15	0.02	-0.1	Decrease
3/19/1999	0.02		0.01	0.02	0.01	Increase
4/21/1999	0.03	<0.01	0.02	0.01	0.01	Decrease
7/29/1999	0.03	0.06	0.045	0.03	-0.015	Decrease
10/15/1999	no outfall	<1	1	1	0	No Change
1/12/2000	0.03	0.02	0.025	0.06	0.035	Increase

Table 3: Phosphate Data

*CCI is the Clover Creek Inlet, **MCI is the Morey Creek Inlet, ***CCO is the Clover Creek Outlet

- all concentration are in mg/L

It should be possible to get values more exact than <0.1 mg/L. It is difficult to draw conclusions from this data as to whether or not McChord AFB adds to the phosphate concentration or not. Most of the time it appears there is no change in the creek as it flows through McChord AFB. According to Dr. Yearsly, a water quality instructor at the University of Washington, healthy phosphorus concentrations for free flowing streams are around 0.1 mg/L, and decreases to 0.05 for streams flowing into a lake. Assuming that the <0.1 values are below 0.05, then the highlighted values in the table would be the ones of concern for this stream.

Dissolved Oxygen:

Date	CCI	MCI	CCO
3/24/1995	1	1	1
6/8/1995	1	1	1
7/26/1995	0.8	0.8	0.8
11/7/1995	1	1	1
1/29/1996	1	1	1

Table 4: Dissolved Oxygen Conc. (mg/l)

Given the few data points provided, dissolved oxygen is very low and does not meet the Washington State water quality standards. It is doubtful that these numbers are accurate. This data stopped being collected after 1996 with no explanation. Since it is a very important parameter for monitoring stream health, it should be reinstated. A different method should be employed so that accurate numbers can be collected, since these are unreasonably low.

Temperature:
The sample temperatures listed in the table are in degrees Celsius. Temperature data is very reasonable and only goes above water quality standards at a few times during the year. (<18°C). It appears that these high temperatures are not due to human influences since inlets are as high as the outlet. There are some blanks in the data set that do not have accompanying explanations. There is also a question as to why some data is reported with decimals and others are not. Highlighted in yellow are values that do not make sense with the other values taken on the same day. A quality check on the data at the time of report would have caught these errors and asked for reasons or for the measurement to be performed again.

Date	CCI	Date	MCI	Date	CCO
3/24/1995	15	3/24/1995	15	3/24/1995	15
6/8/1995	[redacted]	6/8/1995	18	6/8/1995	16
7/26/1995	[redacted]	7/27/1995	[redacted]	7/26/1995	[redacted]
11/7/1995	4	11/7/1995	4	11/7/1995	5
1/29/1996	4.2	1/29/1996	4	1/29/1996	5.5
4/8/1996	11	4/8/1996	9	4/8/1996	10
7/17/1996	15	7/17/1996	15	7/17/1996	14
10/7/1996	14	10/7/1996	13	10/7/1996	12
1/29/1997	5.5	1/29/1997	6	1/29/1997	6
4/9/1997	11	4/9/1997	12	4/9/1997	12
7/2/1997	15	7/2/1997	17	7/2/1997	15
10/13/1997	14	10/13/1997	4	10/13/1997	12
1/14/1998	4	1/14/1998	9	1/14/1998	4
4/8/1998	10	4/8/1998	14	4/8/1998	12
7/28/1998		7/28/1998		7/28/1998	
10/14/1998	9	10/14/1998	12	10/14/1998	11
1/28/1999		1/28/1999		1/28/1999	

Table 5: Temperature Data °C

pH:
The method for pH analysis was not included in the data set. The data provided for pH, however, are very reasonable and only slightly lie outside the water quality standards at a few points (6.5-8.5). pH is a rather simple aspect to monitor due to the ease of tests available. One of the low points is at the Clover Creek Inlet in the summer of 1999 and the other is at the Morey Creek Inlet in the winter of 2000. All of the outflow pH's are within water quality limits according to the data provided. See Table 6 for further detail.

Date	CCI	Date	MCI	Date	CCO
3/24/1995	7.3	3/24/1995	7.1	3/24/1995	7.2
6/8/1995	7	6/8/1995	7	6/8/1995	7.3
7/26/1995	7.3	7/27/1995	7.1	7/26/1995	7.2
11/7/1995	7.1	11/7/1995	7	11/7/1995	7
1/29/1996	7.9	1/29/1996	7.9	1/29/1996	7.9
4/8/1996	7.4	4/8/1996	7.2	4/8/1996	7.3
7/17/1996	7.1	7/17/1996	7.1	7/17/1996	7.1
10/7/1996	7.1	10/7/1996	7.2	10/7/1996	7.3
1/29/1997	7.2	1/29/1997	7.1	1/29/1997	7.3
4/9/1997	7.2	4/9/1997	7.2	4/9/1997	7.3
7/2/1997	6.7	7/2/1997	7.1	7/2/1997	6.7
10/13/1997	6.6	10/13/1997	7.2	10/13/1997	7.1
1/14/1998	6.9	1/14/1998	7	1/14/1998	7
4/8/1998	7.2	4/8/1998	6.9	4/8/1998	6.9
7/28/1998		7/28/1998		7/28/1998	
10/14/1998	7.2	10/14/1998	7.2	10/14/1998	6.7
1/28/1999		1/28/1999		1/28/1999	
4/21/1999		4/21/1999		4/21/1999	
7/29/1999	6.4	7/29/1999	7.14	7/29/1999	6.8
7/29/1999	6.4	7/29/1999	7.14	7/29/1999	6.8
7/29/1999	6.4	7/29/1999	7.14	7/29/1999	6.8
7/29/1999	6.4	7/29/1999	7.14	7/29/1999	6.8
10/15/1999		10/15/1999		10/15/1999	6.7
10/20/1999		10/20/1999		10/20/1999	6.7
1/12/2000	6.6	1/12/2000	6.4	1/12/2000	6.8

Table 6: pH in Streams

Stream Team Comparison:

In addition to the data available from the monitoring done by the environmental services at McChord AFB, another source of data from an outside agency stream team was present in the stream folder. It is of limited value due to missing specific details of who performed the study. There was also no date present on the sheet, but the assumption is that the data was collected in the early 1990's. The results are below in Table 7.

pH = 6.75	Water Appearance was clear, stream bed coating brown with Canarie grass
Nitrate = ~3 mg/L	Depth estimated at > 4 ft, width app. 40'
DO=7.5 mg/L	Time taken for leaf to travel 20'=18.3 sec=1.09 ft/sec
Temperature at 11 C	Discharge is approximately 4*40*1.09=174.4 cfs
No odor	No fish present.

Table 7: Stream Team Data

This stream team observation seems more reasonable in the value found for DO and just a little higher for nitrate concentrations when compared to the available data sheets. The range of values recorded for DO in the data set available is 0.8-1.0 mg/L. Comparing those values to the stream team value of 7.5 mg/L (still below the minimum for Class A streams) indicates that there is some discrepancy in how the data is collected or analyzed in the lab. The flow value also appears very high for this stream.

Extra Data:
Other data collected include values for Oils and Grease, Phenols, Lead, Mercury, and Silver. It is important for the Air Force Base to continue monitoring these due the activities performed on the base. As stated in the introduction, pH and DO are especially important when determining the health of a stream and the effects of the nutrients in them. These other items are also important from a toxic and environmental hazard perspective.

Phenol:

Date	CCI	Date	MCI	Date	CCO
3/24/1995	< 10	3/24/1995	< 10	3/24/1995	< 10
6/8/1995	< 10	6/8/1995	15	6/8/1995	< 10
7/26/1995	< 10	7/27/1995	< 10	7/26/1995	30
11/7/1995	10	11/7/1995	21	11/7/1995	56
1/29/1996	< 10	1/29/1996	< 10	1/29/1996	< 10
4/8/1996	27	4/8/1996	< 10	4/8/1996	< 10
7/17/1996	< 10	7/17/1996	< 10	7/17/1996	< 10
10/7/1996	< 10	10/7/1996	< 10	10/7/1996	< 10
1/29/1997	< 10	1/29/1997	< 10	1/29/1997	< 10
4/9/1997	<10	4/9/1997	<10	4/9/1997	<10
7/2/1997	<10	7/2/1997	<10	7/2/1997	<10
10/13/1997	<10	10/13/1997	< 10	10/13/1997	< 10
1/14/1998	<10	1/14/1998	< 10	1/14/1998	<10
4/8/1998	<10	4/8/1998	< 10	4/8/1998	<10
7/28/1998		7/28/1998		7/28/1998	
10/14/1998	<0.005	10/14/1998	<0.005	10/14/1998	<0.005
1/28/1999	<0.005	1/28/1999	<0.005	1/28/1999	<0.005
4/21/1999	<0.1	4/21/1999	<0.1	4/21/1999	0.1
4/21/1999		4/21/1999		4/21/1999	
7/29/1999	<0.1	7/29/1999	0.1	7/29/1999	<0.1
7/29/1999		7/29/1999		7/29/1999	
10/15/1999		10/20/1999		10/15/1999	
1/12/2000		10/15/1999		10/20/1999	
1/12/2000	<0.1	1/12/2000	<0.1	1/12/2000	<0.1

Table 8: Phenol Conc. (mg/l)

The phenol concentrations vary widely from 1995 to 2000. In the year of 1998, data points go from <10 mg/l to <0.005 mg/l. Either there was a change made it the sampling technique or the labs analyzing technique. If analysis of the data was completed after each data point is entered into the database, someone could have made a comment as to what caused the change. There is a quality control issue with this data.

Pentachlorophenol is the only phenol addressed in WQS and is a function of pH. (A sample calculation assuming pH =7.5 yields an acute limit of 9.45 g/L.)

Oil and Grease:

Date	CCI	Date	MCI	Date	CCO
3/24/1995	1.7	3/24/1995	0.3	3/24/1995	0.8
6/8/1995	0.6	6/8/1995	1	6/8/1995	0.3
7/26/1995	1.68	7/27/1995	0.3	7/26/1995	0.68
11/7/1995	7.36	11/7/1995	9.12	11/7/1995	4.8
1/29/1996	0.4	1/29/1996	0.4	1/29/1996	0.4
4/8/1996	0.6	4/8/1996	0.6	4/8/1996	0.3
7/17/1996	0.32	7/17/1996	1.84	7/17/1996	0.3
10/7/1996	0.64	10/7/1996	0.3	10/7/1996	0.32
1/29/1997	0.64	1/29/1997	0.48	1/29/1997	6.16
4/9/1997	<0.3	4/9/1997	BIT	4/9/1997	<0.3
7/2/1997	0.34	4/29/1997	<0.3	7/2/1997	<0.3
10/13/1997	0.31	7/2/1997	<0.3	10/13/1997	<0.3
1/14/1998	0.4	10/13/1997	0.4	1/14/1998	0.3
4/8/1998	0.5	1/14/1998	<0.3	4/8/1998	0.4
7/28/1998		4/8/1998	<0.3	7/28/1998	
10/14/1998	<5	7/28/1998		10/14/1998	<5
1/28/1999	<1	10/14/1998	<5	1/28/1999	<1
3/19/1999		1/28/1999	<1	3/19/1999	
4/21/1999		4/21/1999		4/21/1999	
4/21/1999	<1	4/21/1999	<1	4/21/1999	<1
7/29/1999	<1	7/29/1999	<1	7/29/1999	<1
7/29/1999		7/29/1999		10/15/1999	1.7
10/15/1999		10/20/1999		10/15/1999	1.7
1/12/2000		10/15/1999	1.2	10/20/1999	
1/12/2000	<0.1	1/12/2000	<1	1/12/2000	<1

Table 9: Oil and Grease Conc. (mg/l)

Oil and grease data is very important for the Air Force Base to collect due to their mission and car traffic on the base. These materials find their way into waterways rather easily with help from the precipitation received in the Pacific Northwest. There are, however, problems with this data from a quality control aspect. Clover Creek Inlet, Morey Creek Inlet and the Outlet all have very high concentration values in November of 1995 compared with the rest of the data set. The Outlet value for January of 1997 should have also raised concern with the oil and grease level or that inaccurate sampling was done.

Miscellaneous:

Clover Creek Inlet				Morey Creek Inlet				Clover Creek Outlet			
DATE	LEAD mg/L	MERCURY mg/L	SILVER mg/L	DATE	LEAD mg/L	MERCURY mg/L	SILVER mg/L	DATE	LEAD mg/L	MERCURY mg/L	SILVER mg/L
3/24/1995	< 0.02	< 0.0002	< 0.01	3/24/1995	< 0.02	< 0.0002	< 0.01	3/24/1995	< 0.02	< 0.02	< 0.01
6/8/1995	< 0.02	< 0.0002	< 0.01	6/8/1995	< 0.02	< 0.0002	< 0.01	6/8/1995	< 0.02	< 0.02	< 0.01
7/26/1995	< 0.02	< 0.0002	< 0.01	7/27/1995	< 0.02	< 0.0002	< 0.01	7/26/1995	< 0.02	< 0.02	< 0.01
11/7/1995	< 0.02	< 0.0002	< 0.01	11/7/1995	< 0.02	< 0.0002	< 0.01	11/7/1995	< 0.02	< 0.02	< 0.01
1/29/1996	< 0.02	< 0.0002	< 0.01	1/29/1996	< 0.02	< 0.0002	< 0.01	1/29/1996	< 0.02	< 0.0002	< 0.01
4/8/1996	< 0.02	< 0.0002	< 0.01	4/8/1996	< 0.02	< 0.0002	< 0.01	4/8/1996	< 0.02	< 0.0002	< 0.01
7/17/1996	< 0.02	< 0.0002	< 0.01	7/17/1996	< 0.02	< 0.0002	< 0.01	7/17/1996	< 0.02	< 0.0002	< 0.01
10/7/1996	< 0.02	< 0.0002	< 0.01	10/7/1996	< 0.01	< 0.0002	< 0.01	10/7/1996	< 0.02	< 0.0002	< 0.01
1/29/1997	< 0.02	< 0.0002	< 0.01	1/29/1997	< 0.01	< 0.0002	< 0.01	1/29/1997	< 0.02	< 0.0002	< 0.01
4/9/1997	<0.02	<0.0002	<0.01	4/9/1997	<0.02	<0.0002	<0.01	4/9/1997	<0.02	<0.0002	<0.01
7/2/1997	<0.02	<0.0002	<0.01	4/29/1997				7/2/1997	<0.02	<0.0002	<0.01
10/13/1997	<0.02	<0.0002	<0.01	7/2/1997	<0.02	<0.0002	<0.01	10/13/1997	< 0.02	< 0.0002	< 0.01
1/14/1998	<0.02	<0.0002	<0.01	10/13/1997	< 0.02	< 0.0002	< 0.01	1/14/1998	<0.02	<0.0002	<0.01
4/8/1998	<0.02	<0.0002	<0.01	1/14/1998	< 0.01	< 0.0002	< 0.01	4/8/1998	<0.02	<0.0002	<0.01
7/28/1998				4/8/1998	< 0.01	< 0.0002	< 0.01	7/28/1998			
10/14/1998	0.017	<0.0002	<0.002	7/28/1998				10/14/1998	<0.01	<0.0002	<0.002
1/28/1999				10/14/1998	<0.01	0.00169	<0.002	1/28/1999			
3/19/1999				1/28/1999	<0.010	0.0002	<0.002	3/19/1999			
4/21/1999				4/21/1999				4/21/1999			
4/21/1999				4/21/1999				4/21/1999			
4/21/1999	<0.010	<0.0002	<0.0020	4/21/1999	<0.010	0.0002	<0.002	4/21/1999	<0.010	<0.0002	<0.0020
7/29/1999				7/29/1999				7/29/1999			
7/29/1999				7/29/1999				7/29/1999			
7/29/1999				7/29/1999	<0.010	<0.00020	<0.0020	7/29/1999	<0.010	<0.0002	<0.0020
7/29/1999	<0.010	<0.0002	<0.0020	10/20/1999	<0.01	<0.0002	<0.0020	10/15/1999			
10/15/1999				10/15/1999				10/20/1999	<0.01	<0.0020	<0.0020
1/12/2000	<0.010	<0.0002	<0.002	1/12/2000	<0.01	<0.0002	<0.002	1/12/2000	<0.01	<0.002	<0.002
1/12/2000				1/12/2000				1/12/2000			

Table 10: Miscellaneous Data points (mg/l)

This last table of data is also important to analyze since heavy metals are common around the Air Force Base and cause toxicity concerns if they infiltrate the stream. The concentrations reported are very low and seem to have no increase as the stream flows through the base. If a change were to be seen in the data collected, then hardness would need to be analyzed. Metal toxicity is a function of water hardness and the WQS define the limit in terms of water hardness.

Fish:

The last data item is a cutthroat trout study completed by area fish biologist for the State of Washington on 20 September 1990. At least six different age groups of trout are present in stream indicating that many life stages flourish. Ensuring that the fish continue to thrive in the stream provides another reason to monitor and protect the stream.

Monitoring Program Recommendations:
After reviewing the data provided, the recommendations that follow will improve the current monitoring program. It is important to note that up until recently, no TMDL's (Total Maximum Daily Loads) had been determined for this stretch of Clover Creek even though other segments have problems with DO, temperature and fecal Coliform. There is now a phosphate loading concern for the creek so improvement to the monitoring program is desired. The six steps for program improvement include:

1. Outlining specific goals for the monitoring program
2. Identifying what and where to monitor
3. Determining the frequency and timing of sampling
4. Explaining the training of the samplers
5. Using standard methods sampling techniques and tests
6. Setting up a review plan for the collected data

All of these ideas are building blocks to a quality assurance plan and will aid in making the data collected more reliable, dependable, and defendable.

1. Outlining Goals of the Program: One of the first pages in the stream folder for the monitoring program should include the goals of the program. In this case, possible goals are (1) screening for potential pollution problems, (2) determining the influence McChord AFB has on the pollution of the stream and (3) monitoring the overall health of the stream.

2. What and Where to Monitor? Next, determine what aspects of water quality and stream characteristics to focus on for the monitoring program. Below are the items recommended for this project and reasons for monitoring them.

1. Water Temperature: Important for water quality analysis and also meeting the Class A Stream requirements.
2. pH: One of the most important aspects of water chemistry and there is also a standard for Class A Streams.
3. Dissolved Oxygen: A good indicator of health for streams and is needed for aquatic life to thrive in addition to meeting the water quality standard.
4. Nitrate: An essential nutrient that needs to be monitored to ensure that high concentrations do not exist and enhance eutrophication downstream.
5. Phosphorus (Phosphate or orthophosphates): Also an essential nutrient that is of utmost important in this program due to the downstream lake cyanobateria blooms.
6. Phenol: Can be present in industrial areas and react with oxidizing agents to produce odors, etc.
7. Oils and Grease: May cause surface films and affect aerobic and anaerobic biological processes.
8. Metals (Lead, Mercury and Silver): Heavy metals are toxic and are cause for concern if found in certain concentrations in aquatic environments.
9. Flow: While not important for water quality issues, it is beneficial to know the flow when doing analysis of two streams converging into one and aid in future modeling efforts.

10. Fish: Fish are easily understood by the public and if fish continue to thrive in the stream it is a good indicator that the stream is healthy.
11. Photographic surveys: Pictures convey a message more easily and with detail for the public.

The location of the sampling can continue to be at the two stream inlets and at the one outlet from the base since these three data points will satisfy the goals. However, additional data can be collected upstream and downstream of the four major storm drain outfalls to better monitor the contributions McChord AFB makes to the streams. At these additional locations, all items do not need to be monitored but testing for pH, temperature, DO, nitrate and phosphorus would be good for monitoring changes that occur in the stream around the outfalls.

3. Determining the Frequency and Timing of Sampling: After determining what is important to monitor, the frequency and timing of the sampling should be assessed. It is recommended that chemical monitoring occur monthly and biological assessments occur biannually. Due to cost constraints and the nature of this volunteer monitoring effort, the quarterly sampling can continue for McChord AFB. Flow data should be collected each time chemical samples are taken. Samples should be taken at the same time of the month and day to ensure that biological influence on nutrient levels and DO are consistent throughout the data set. (For example, the winter monitoring can always occur in the first week of February from 0900-1000). Fish monitoring can occur once every two years to limit the impact on the fish. Pictures can be taken at points of interest once or twice a year.

4. Explanation of the Training for Samplers: A brief description should be included of how the samplers are trained for the program. For example, a checklist can be made that identifies that this person has shown the proper way to prepare the sample container, take a sample, preserve a sample if necessary, use the pH or DO probes, read the thermometer accurately, etc. The person who checks off on the training can come from an accredited lab or governmental agency that is experienced in taking samples like the Department of Ecology (DOE) or the Environmental Protection Agency (EPA).

5. Using Standard Methods for Sampling and Analysis: Using standard methods that are approved by the EPA add credibility to the monitoring program. The methods that are recommended for this program are gathered from the 19th ed. of *Standard Methods for the Examination of Water and Wastewater.* Attachment 3 describes in detail how sampling and testing should occur for the first eight items that are of interest to monitor. Attachment 4 is useful for determining stream flow.

The following table is a summary adapted from Table 1060 of *Standard Methods*:

Item of Interest	Container for Sampling	Minimum Size of Sample	Grab or Continuous	Preservation Technique	Max Time Stored (Recommended/Required by EPA)
Nitrate	Plastic, Glass	100 mL	Grab[3]	Analyze ASAP or refrigerate	48 hr/ 48 hr

Phosphorous	Glass (A)[1]	100 mL	Grab	Refrigerate	48 hr/ Not specified
DO	G	300 mL	Grab	Analyze ASAP	.5 hr/ immediate
PH	P, G	50 mL	Grab	Analyze ASAP	2 hr/ immediate
Temperature	P, G	--	Grab	Analyze ASAP	immediate/immediate
Phenols	P, G	500 mL	Grab	Ref., add H_2SO_4 to pH<2	--/28 days
Oils and Grease	Glass [2]	1000 mL	Grab	Add HCl to pH <2, ref.	28 days/28 days
Lead	P (A), G(A)	500 mL	Grab	Add HNO_3 to pH <2, ref.	28 days/28 days
Mercury	P (A), G(A)	500 mL	Grab	Same as above	28 days/28 days
Silver	P (A), G(A)	500 mL	Grab	Same as above	28 days/28 days

Table 11: Summary of Standard Methods for Sampling

[1] (A) denotes the need to rinse container with 1 + 1 HNO_3 solution

[2] This container needs to be a wide mouth calibrated container

[3]Grab samples can be used for each of the items in the table. When a source is known to be relatively constant in composition, a sample taken at one point at a certain time can represent a longer time period and larger volume.

Samples that can be tested in the field by the trained personnel are DO, temperature, and pH. All other samples should be preserved and sent to an accredited lab in the area. A state accredited lab can be found though WAC 173-050 or Ecology Executive Policy 1-22.

6. Setting up a Review Plan for the Collected Data: Dealing with the data collected is another important aspect. Field sheets (Attachment 5) and lab data sheets should be checked for completeness, data should be screened for outliers, and a database should be developed or adapted to store and manipulate the data. A disk is provided as well as a print out of a sample sheet for storing the data (Attachment 6). The elements of such a database should be clearly explained in order to allow users to interpret the data accurately and with confidence.

Quality Control Issues: Aspects to consider for quality control follows:

> "There should be internal checks for the sample and data monitoring. One of these checks should be a *Field Blank.* A field blank is deionized water that is treated as a sample. It is used to identify errors or contamination in sample collection and analysis. In addition, *Field Duplicates,* can be used to estimate sampling and laboratory analysis precision. A *Calibration Blank* can be used to "zero" the instruments. It is the first "sample" analyzed and used to set the meter to zero. This is different from the field blank in that it is "sampled" in the lab. It is used to check the measuring instrument periodically for "drift" (the instrument should always read "0" when this blank is measured). It can also be compared to the field blank to pinpoint where contamination might have occurred." (Reference-Volunteer Stream Monitoring: A methods Manual)

External checks are also needed and can be are performed by non-volunteer field staff and a lab (also known as a "quality control lab"). The results are compared with those obtained by the project lab. This can occur once a year or once every two years depending on cost constraints.

Continuing Efforts:
The last aspect to consider, for purposes of this report, is to continue the tree planting effort of alders along the stream bank. This will help with erosion, nitrogen levels, shading, and overall health of the water. Poplars can also be used for this purpose with the added bonus of phyto-remediation occurring for some toxic pollutants and their ability to slow toxic water plums that may become a problem in the future. Trees are also beneficial for the carbon/oxygen cycle in the environment and pleasing to the eye in terms of aesthetics for the base. See Figure 5 below.

Figure 5: Alder tree planting efforts on McChord AFB.

Conclusion:

Clover Creek and Morey Creek, which flow onto McChord Air Force Base, need to be monitored. This is done to provide substantiation that the Air Force Base does or does not have a detrimental effect on the streams as they flow through the base. The data that has already been collected was analyzed and some conclusions were drawn for nitrates and phosphates. In general nitrate concentrations increased slightly as the stream flowed through the base and phosphate concentrations had not change. McChord AFB does not detrimentally impact nutrient levels while the stream is on the base. By adapting the recommendations provided in the report, McChord AFB will be closer to having a quality-monitoring program. A healthy stream is currently present on the base and will continue to be healthy with a good monitoring program and other efforts by the Air Force.

Clover Creek Inlet to McChord AFB looking toward the west.

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References and Additional Sources:

Chapra, Steven C., Surface Water-Quality Modeling. McGraw-Hill, New York 1997.

Chapter 173-050 WAC, "Water Quality Standards for Surface Waters for the State of Washington"

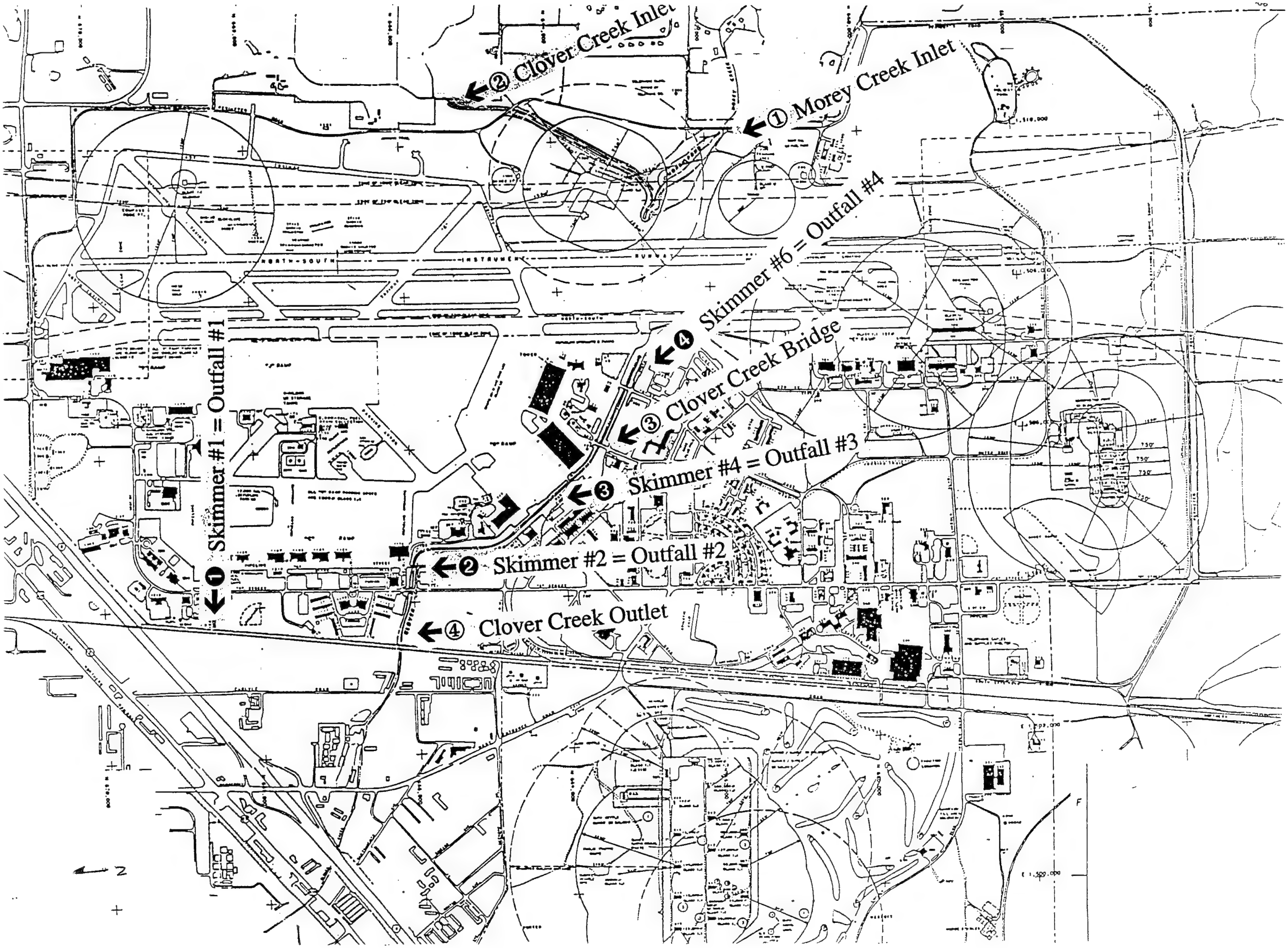
Ecology Executive Policy 1-22 for the State of Washington.

EPA document: "Volunteer Stream Monitoring: A Methods Manual", http://www.epa.gov/owow/monitoring/volunteer, (Chapter 5 of Volunteer Stream Monitoring.)

Standard Methods for the Examination of Water and Wastewater. Ed. Andrew Eaton, Lenore Clesceri, and Arnold Greenberg. 19th ed. Maryland: United Book Press, 1917-1995.

Watch Over Washington group documents, http://www.wa.gov/ecology/wq/wow/db/index.cgi, "The Volunteers Monitor's Guide to Quality Assurance Project Plans."

Attachment 1: Map of McChord AFB


② Clover Creek Inlet
① Morey Creek Inlet
Skimmer #6 = Outfall #4
❹
③ Clover Creek Bridge
❸ Skimmer #4 = Outfall #3
❷ Skimmer #2 = Outfall #2
④ Clover Creek Outlet
❶ Skimmer #1 = Outfall #1
N

Attachment 2: Data Sheets

Stream Results Report

Date	Sample Number	Oils and Grease	Dissolved O2	Phenols	Lead	Mercury	Silver	Temp Deg C	pH	Phosphate	Nitrates
Clover Creek Inlet											
	GN990056	<1		<0.005							
3/24/95	GN950306	1.7	1	< 10	< 0.02	< 0.0002	< 0.01	15	7.3	< 0.1	1.96
6/8/95	GN950712	0.6	1	< 10	< 0.02	< 0.0002	< 0.01	19	7	< 0.1	1.22
7/26/95	GN950879	1.68	0.8	< 10	< 0.02	< 0.0002	< 0.01	19	7.3	< 0.1	0.59
11/7/95	GN951220	7.36	1	10	< 0.02	< 0.0002	< 0.01	4	7.1	< 0.1	0.82
1/29/96	GN960110	0.4	1	< 10	< 0.02	< 0.0002	< 0.01	4.2	7.9	0.013	1.3
4/8/96	GN960244	0.6		27	< 0.02	< 0.0002	< 0.01	11	7.4	< 0.1	1.48
7/17/96	GN960396	0.32		< 10	< 0.02	< 0.0002	< 0.01	15	7.1	< 0.1	0.68
10/7/96	GN960568	0.64		< 10	< 0.02	< 0.0002	< 0.01	14	7.1	< 0.1	0.56
1/29/97	GN970025	0.64		< 10	< 0.02	< 0.0002	< 0.01	5.5	7.2	< 0.1	1.58
4/9/97	GN970094	<0.3		<10	<0.02	<0.0002	<0.01	11	7.2	<0.1	1.26
7/2/97	GN970173	0.34		<10	<0.02	<0.0002	<0.01	15	6.7	<0.1	0.35
10/13/97	GN970289	0.31		<10	<0.02	<0.0002	<0.01	14	6.6	< 0.1	0.38
1/14/98	GN980011	0.4		<10	<0.02	<0.0002	<0.01	4	6.9	< 0.1	1.2
4/8/98	GN980089	0.5		<10	<0.02	<0.0002	<0.01	10	7.2	<0.1	1.28
7/28/98	GN980250										
10/14/98	GN980334	<5		<0.005	0.017	<0.0002	<0.002	9	7.2	0.27	0.32* N&N
3/19/99	GN990130									0.02	1.7
4/21/99	GN990191			<0.1							
4/21/99	GN990190	<1									
4/21/99	GN990189				<0.010	<0.0002	<0.0020				
4/21/99	GN990190									0.03	1.4
7/29/99	GN991175							16	6.4	0.03	0.8
7/29/99	GN991176	<1						16	6.4		
7/29/99	GN991177			<0.1				16	6.4		
7/29/99	GN991178				<0.010	<0.0002	<0.0020	16	6.4		
10/15/99	no outfall										
1/12/00	GN000002				<0.010	<0.0002	<0.002	3	6.6		
1/12/00	GN000001	<0.1		<0.1						0.03	1.3

Stream Results Report

Date	Sample Number	Oils and Grease	Dissolved O2	Phenols	Lead	Mercury	Silver	Temp Deg C	pH	Phosphate	Nitrates
Clover Creek Outlet											
3/24/95	GN950310	0.8	1	< 10	< 0.02	< 0.02	< 0.01	15	7.2	< 0.1	1.8
6/8/95	GN950716	0.3	1	< 10	< 0.02	< 0.02	< 0.01	16	7.3	< 0.1	1.6
7/26/95	GN950880	0.68	0.8	30	< 0.02	< 0.02	< 0.01	19	7.2	< 0.1	0.94
11/7/95	GN951228	4.8	1	56	< 0.02	< 0.02	< 0.01	5	7	< 0.1	0.44
1/29/96	GN960112	0.4	1	< 10	< 0.02	< 0.0002	< 0.01	5.5	7.9	0.11	1.9
4/8/96	GN960248	0.3		< 10	< 0.02	< 0.0002	< 0.01	10	7.3	< 0.1	1.38
7/17/96	GN960398	0.3		< 10	< 0.02	< 0.0002	< 0.01	14	7.1	< 0.1	1.15
10/7/96	GN960567	0.32		< 10	< 0.02	< 0.0002	< 0.01	12	7.3	0.2	1.32
1/29/97	GN970026	6.16		< 10	< 0.02	< 0.0002	< 0.01	6	7.3	< 0.1	2.08
4/9/97	GN970095	<0.3		<10	<0.02	<0.0002	<0.01	12	7.3	<0.1	1.35
7/2/97	GN970174	<0.3		<10	<0.02	<0.0002	<0.01	15	6.7	<0.1	0.75
10/13/97	GN970291	<0.3		< 10	< 0.02	< 0.0002	< 0.01	12	7.1	< 0.1	0.56
1/14/98	GN980013	0.3		<10	<0.02	<0.0002	<0.01	4	7	<0.1	1.34
4/8/98	GN980091	0.4		<10	<0.02	<0.0002	<0.01	12	6.9	<0.1	1.26
7/28/98	GN980252										
10/14/98	GN980330	<5		<0.005	<0.01	<0.0002	<0.002	11	6.7	<0.02	0.68* N&N
1/28/99	GN990057	<1		<0.005							
3/19/99	GN990131									0.02	1.8
4/21/99	GN990195	<1									
4/21/99	GN990194									<0.01	1.5
4/21/99	GN990196			0.1							
4/21/99	GN990193				<0.010	<0.0002	<0.0020				
7/29/99	GN991179							15	6.8	0.03	1.2
7/29/99	GN991182				<0.010	<0.0002	<0.0020	15	6.8		
7/29/99	GN991181			<0.1				15	6.8		
7/29/99	GN991180	<1						15	6.8		
10/15/99	GN991390	1.7						14	6.7	1	0.05
10/15/99	GN991391	1.7									
10/20/99	GN991393				<0.01	<0.0020	<0.0020	14	6.7		
10/20/99	GN991392										
1/12/00	GN000005	<1		<0.1						0.06	1.4
1/12/00	GN000006				<0.01	<0.002	<0.002	4	6.8		

Stream Results Report

Date	Sample Number	Oils and Grease	Dissolved O2	Phenols	Lead	Mercury	Silver	Temp Deg C	pH	Phosphate	Nitrates
Morey Creek Inlet											
3/24/95	GN950302	0.3	1	< 10	< 0.02	< 0.0002	< 0.01	15	7.1	< 0.1	1.8
6/8/95	GN950708	1	1	15	< 0.02	< 0.0002	< 0.01	18	7	< 0.1	1.34
7/27/95	GN950881	0.3	0.8	< 10	< 0.02	< 0.0002	< 0.01	19	7.1	< 0.1	0.78
11/7/95	GN951224	9.12	1	21	< 0.02	< 0.0002	< 0.01	4	7	< 0.1	0.56
1/29/96	GN960111	0.4	1	< 10	< 0.02	< 0.0002	< 0.01	4	7.9	< 0.11	2.12
4/8/96	GN960246	0.6		< 10	< 0.02	< 0.0002	< 0.01	9	7.2	< 0.1	1.38
7/17/96	GN960397	1.84		< 10	< 0.02	< 0.0002	< 0.01	15	7.1	< 0.1	0.97
10/7/96	GN960566	0.3		< 10	< 0.01	< 0.0002	< 0.01	13	7.2	< 0.1	0.8
1/29/97	GN970024	0.48		< 10	< 0.01	< 0.0002	< 0.01	6	7.1	< 0.1	1.8
4/9/97	GN970093	BIT		<10	<0.02	<0.0002	<0.01	12	7.2	<0.1	1.32
4/29/97	GN970108	<0.3									
7/2/97	GN970172	<0.3		<10	<0.02	<0.0002	<0.01	17	7.1	<0.1	0.68
10/13/97	GN970290	0.4		< 10	< 0.02	< 0.0002	< 0.01	4	7.2	< 0.1	0.56
1/14/98	GN980012	<0.3		< 10	< 0.01	< 0.0002	< 0.01	9	7	< 0.1	1.36
4/8/98	GN980090	<0.3		< 10	< 0.01	< 0.0002	< 0.01	14	6.9	<0.1	1.3
7/28/98	GN980251										
10/14/98	GN980338	<5		<0.005	<0.01	0.00169	<0.002	12	7.2	0.03	0.52* N&N
1/28/99	GN990055	<1		<0.005	<0.010	0.0002	<0.002				
4/21/99	GN990199	<1									
4/21/99	GN990200			<0.1							
4/21/99	GN990197				<0.010	0.0002	<0.002				
4/21/99	GN990198									<0.01	1.4
7/29/99	GN991171							18	7.14	0.06	1.2
7/29/99	GN991172	<1						18	7.14		
7/29/99	GN991173			0.1				18	7.14		
7/29/99	GN991174				<0.010	<0.00020	<0.0020	18	7.14		
10/15/99	GN991386									<1	0.03
10/15/99	GN991387	1.2									
10/20/99	GN991389				<0.01	<0.0002	<0.0020	14			
1/12/00	GN000004				<0.01	<0.0002	<0.002	4	6.4		
1/12/00	GN000003	<1		<0.1						0.02	1.5

Attachment 3: Standard Methods for Sampling and Analysis

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Attachment 3 : Recommended Sampling and Testing Techniques for Monitoring Program

In general, sample containers need to be rinsed with the water being sampled 2 or 3 times before filling the container to within 1% of the container volume. Other requirements are outlined below. The $ sign in front of a term indicates an initial investment needed.

Nitrate: Nitrate is complex to measure and the procedure is complicated. It is best to send a properly prepared sample to a lab for analysis. Since the concentrations we are looking at for surface waters lie between 0.01 mg/L and 10 mg/L, the tests recommended in *Standard Methods* are the **hydrazine reduction** method or the **titanous chloride method**. (cadmium methods are acceptable for the EPA as well)

Preparing the Sample:
Rinse the glass or plastic container with sample water 2 or 3 times
Collect 100 mL of sample to be analyzed
If storage time is less than 24 hours, store sample at 4°C (packed in crushed ice)
If storage time is greater than 24 hours, preserve the sample with 2mL concentration H_2SO_4/L realizing that this method forgoes being able to determine NO_3^- and NO_2^- as different species

(Adapted from section 4500 NO_3 Nitrate of *Standard Methods*)

Phosphorus: Phosphorus occurs in natural waters almost solely as phosphates. Monitoring phosphorus is challenging because it involves measuring very low concentrations down to 0.01 milligram per liter (mg/L) or even lower. Even such very low concentrations of phosphorus can have a dramatic impact on streams. Less sensitive methods should be used only to identify serious problem areas. For this item, the recommended test for labs to perform is the **ascorbic acid colorimetric** determination for dissolved orthophosphate.

Preparing the Sample:
Rinse the glass (absorbs onto plastic so glass is important to use) with hot HCl dilute and then rinse several times with distilled water
Collect 100 mL of sample to be analyzed
Preserve by freezing at or below –10°C

(Adapted from section 4500 P Phosphorus of *Standard Methods*)

$DO: Dissolved oxygen is a very important test. Due to the immediate nature needed for this test, purchasing a **Membrane Electrode** that includes an oxygen sensitive membrane electrode with the appropriate meter will be necessary. Following the manufacturers calibration procedure should yield results + or – 0.1 mg/L.

Preparing the Sample:
Rinse the glass container with sample water 2 or 3 times
A sample of 300 ml is desired for testing
Follow manufacturer instructions

(Adapted from section 4500 O Oxygen (dissolved) of *Standard Methods*)

$pH: pH is one of the most important tests for water chemistry. Similar to DO, the test needs to be performed quickly. A pH meter is needed consisting of a potentiometer, glass electrode, reference electrode, and temperature compensating device. This test should be accurate to tenths (0.1).

Preparing the Sample:
Rinse the plastic or glass container with sample water 2 or 3 times
A sample of 50 ml is desired for testing
Follow manufacturer instructions

(Adapted from section 4500 H^+ pH Value of *Standard Methods*)

$Temperature: Use a good mercury-filled Celsius thermometer scaled every 0.1°C. Periodically check the thermometer against a precision thermometer certified by the National Institute of Standards and Technology.

Preparing the Sample:
Rinse the container with sample water 2 or 3 times
The temperature sample should be taken at a consistent depth as the other samples

(Adapted from section 2550 Temperature of *Standard Methods*)

Phenols: Phenols require a **4-aminoantipyrine colorimetric** method for testing.

Preparing the Sample:
Rinse the container with sample water 2 or 3 times
A sample size of 500 mL is needed
Determine approximately how much H_2SO_4 is needed to make the sample go to <2 pH by taking another sample and adding the acid until it reaches the desired pH
Put that much acid in the prepared container before putting the real sample in
Refrigerate the sample

(Adapted from section 5530 Phenols of *Standard Methods*)

Oils and Grease: Oil and grease is defined as any material recovered as a substance soluble in the solvent. Groups of substances are determined based on their common solubility in an organic extracting solvent. The method desired for the lab since concentrations are < 10 mg/L is the **partition infrared** method. This is the method of choice because gravimetric methods do not provide the needed precision.

Preparing the Sample:
Collect the sample is a wide-mouth glass bottle that has been washed with soap and rinsed with water
Rinse the container with the solvent trichlorotrifluoroethane
Collect two samples for oil and grease of 1000 mL each
If being preserved for greater than 2 hours, acidify to <2 pH with HCl (similar to the method for phenol)
Refrigerate

(Adapted from section 5520 Oil and Grease of *Standard Methods*)

Lead: Natural waters rarely contain concentrations of lead greater than 5 g/L. Suggest that the lab perform the **electro-thermal atomic absorption spectrometric** method or the **colorimetric dithizon** method.

Preparing the Sample:
Rinse the glass or plastic container with 1 + 1 HNO_3 solution
Collect a 500 mL sample
For preservation add HNO_3 to reduce the sample pH to <2 (similar to the method for phenol)
Refrigerate

(Adapted from section 3500 Pb Lead of *Standard Methods*)

Mercury: The method for mercury is different than that of solver and lead. Have the labs perform the **cold vapor atomic absorption** method.

Preparing the Sample:
Rinse the glass or plastic container with 1 + 1 HNO_3 solution
Collect a 500 mL sample
For preservation add HNO_3 to reduce the sample pH to <2 (similar to the method for phenol)
Refrigerate

(Adapted from section 3500 Hg Mercury of *Standard Methods*)

Silver: Toxic effects on fish have been seen at concentrations as low as 0.17 g/L. Suggest that the lab perform the **electro-thermal atomic absorption spectrometric** method for this metal as well.

Preparing the Sample:
Rinse the glass or plastic container with 1 + 1 HNO_3 solution
Collect a 500 mL sample
For preservation add HNO_3 to reduce the sample pH to <2 (similar to the method for phenol)
Refrigerate

(Adapted from section 3500 Ag Silver of *Standard Methods*)

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Attachment 4: Flow Worksheet

DATA FORM FOR CALCULATING FLOW

Solving the equation: $\text{Flow} = \frac{A\,L\,C}{T}$

Where:

A = Average cross-sectional area of the stream. L = Length of the stream reach measured (usually 20 ft.).
C = A coefficient or correction factor (0.8 for rocky-bottom streams or 0.9 for muddy-bottom streams). T = Time, in seconds, for the float to travel the length of L.

A: Average Cross-Sectional Area

Transect #1 (upstream)

	Interval width (feet)	Depth (feet)	
A to B =	____	____	(at B)
B to C =	____	____	(at C)
C to D =	____	____	(at D)
D to E =	____	____	(shoreline)
Totals	☐	☐ ÷ 4	

= Avg. depth ☐ ft

Cross-sectional area of Transect #1

= Total width (ft) X Avg. depth (ft)

☐ X ☐ = ☐ ft^2

Transect #2 (downstream)

	Interval width (feet)	Depth (feet)	
A to B =	____	____	(at B)
B to C =	____	____	(at C)
C to D =	____	____	(at D)
D to E =	____	____	(shoreline)
Totals	☐	☐ ÷ 4	

= Avg. depth ☐ ft

Cross-sectional area of Transect #2

= Total width (ft) X Avg. depth (ft)

☐ X ☐ = ☐ ft^2

(Cross-sectional area of Transect #1 + Cross-sectional area of Transect #2) ÷ 2 = Average Cross-sectional area

☐ X ☐ = ☐ ft^2

L: Length of Stream Reach

☐ ft

C: Coefficient

☐

T: Travel Time

	Travel Time of Float (sec.)
Trial #1	____
Trial #2	____
Trial #3	____
Total	☐ ÷ 3

= Avg. time ☐ sec.

Flow = $\frac{A\,L\,C}{T}$ = $\frac{\square\ \square\ \square}{\square}$ = ☐ **ft^3/sec.**

Attachment 5: Data Sheets for Field Collection

Water Quality Sampling Field Data Sheet:

Date: ______ Time: ______

Name(s) of Personnel Participating: ______

Location: ______

Brief Description of Location: (Vegetation present, Weather Conditions, etc.)

______

______

Parameter	Sample No.	Container No.	Field Measurment	Time Delivered to Lab	Additional Notes
Temperature					
pH					
DO					
Nitrate					
Phosphorus					
Phenol					
Oils and Grease					
Lead					
Mercury					
Silver					

Flow Estimate from Flow Data Form: ______ cfs

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Attachment 6: Example Data Base Sheets for Storing and Analysis

Nitrate:

Date	Morey Creek Inlet	Clover Creek Inlet	Clover Creek Outlet	Change from Inlets to Outlet	Important Notes: (Including Lab Blank results, etc.)

Dissolved Oxygen:

WQS>8.0 mg/L

Date	Morey Creek Inlet	Clover Creek Inlet	Clover Creek Outlet	Change from Inlets to Outlet	Important Notes from Field Sheet:

TEMPERATURE:

WQS<18 C

Date	Morey Creek Inlet	Clover Creek Inlet	Clover Creek Outlet	Change from Inlets to Outlet	Important Notes: